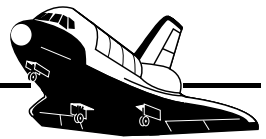


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Mission Highlights STS-51



Space Shuttle *Discovery* September 12 - 22, 1993

Commander: Frank L. Culbertson, Jr.,
(CAPT, USN)

Pilot: William F. Readdy (CDR, USNR)

Mission Specialist: Daniel W. Bursch,
(CDR, USN)

Mission Specialist: James H. Newman
(Ph.D.)

Mission Specialist: Carl E. Walz (LTCOL,
USAF)



Deployment of ACTS-TOS

Major Mission Accomplishments

- Successfully deployed the Advanced Communications Technology Satellite (ACTS) with the Transfer Orbit Stage (TOS). ACTS is a test bed for the next generation of communications technology.
- Completed the deployment and retrieval of the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrograph (ORFEUS) science experiment flown on the Shuttle Pallet Satellite (SPAS).
- Conducted an Extravehicular Activity (EVA) performance test in preparation for the Hubble Space Telescope servicing mission.
- Continued research into high quality protein crystal growth in microgravity using the Commercial Protein Crystal Growth (CPCG) experiment.
- Demonstrated the first successful use of the Global Positioning System (GPS) aboard the Space Shuttle.
- Conducted manually flown Orbiter maneuvers for the IMAX camera mounted on the ORFEUS-SPAS after deployment. For the first time, obtained eleven IMAX exterior Orbiter views before and after ORFEUS retrieval.
- Tested the effects of the Orbiter's Remote Manipulator System (RMS) robot arm movements on the Orbiter's attitude in preparation for the STS-60 Shuttle mission.
- Successfully demonstrated the first use of the Extended Range Payload Communications Link (ERPCL) for two-way communication between free-flying payloads and the ground via the Orbiter.
- Completed the first night landing at the Kennedy Space Center's Shuttle Landing Facility (SLF).

If at first you don't succeed, try, try, try... and try again. A phrase taken to heart as the Space Shuttle *Discovery* began the 57th Space Shuttle mission a couple of months later than originally scheduled. Everything from technical problems with the world's most complex flying machine to nature's own Perseids Meteor shower postponed the launch five times. The launch was a welcome beginning to a mission that could lead to significant breakthroughs in two very different fields: communications technology and astrophysics. The objectives of the Space Shuttle Mission STS-51 were to deploy both the Advanced Communications Technology Satellite (ACTS) and the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrograph (ORFEUS). The ACTS satellite was successfully boosted to a 35,889 kilometer geosynchronous, equatorial orbit at 100 degrees west longitude by a Transfer Orbit Stage (TOS) upper stage booster and an apogee kick motor. ORFEUS, mounted on a Shuttle Pallet Satellite (SPAS), was retrieved and brought back to Earth at the end of the ten-day flight to be re-used. Two of the crewmembers also performed a seven hour and five minute extravehicular activity (EVA) on flight day five. This was the third in a series of generic space walks begun this year in preparation for the Hubble Space Telescope servicing mission and to gain further EVA experience.

ACTS

Immediately after launch, the crew's focus was on the deployment of ACTS. ACTS is an orbiting test bed for new communications technologies and a prototype for the next generation of commercial communication satellites. ACTS could lower the cost and enable new services such as global personal communications even from remote areas, real time television transmission to airlines, and remote transmission of medical imagery for diagnosis. The many potential applications for ACTS technologies are evidenced by the diversity of organizations sponsoring experiments with the satellite, including the U.S. Army Space Command, Mayo Foundation, Public Broadcasting Service, American Express, and COMSAT Laboratories. To date, some 75 experiments using more than 40 Earth terminals are planned by over 80 investigators.

Among ACTS-TOS many innovations are: multiple, fast hopping spot beams, and Ka-band technologies. The onboard computer electronically sorts and routes signal traffic without going through a ground station. The multiple, fast, hopping spot beams are narrower and more high-powered than those generated by current generation satellites. Spot beam technology can be used to link geographically dispersed areas. Spot beams will allow reductions in the size and cost of Earth stations, while limiting user cost through on-demand access. Use of Ka-band has been limited because Ka-bands scatter when they pass through rain.



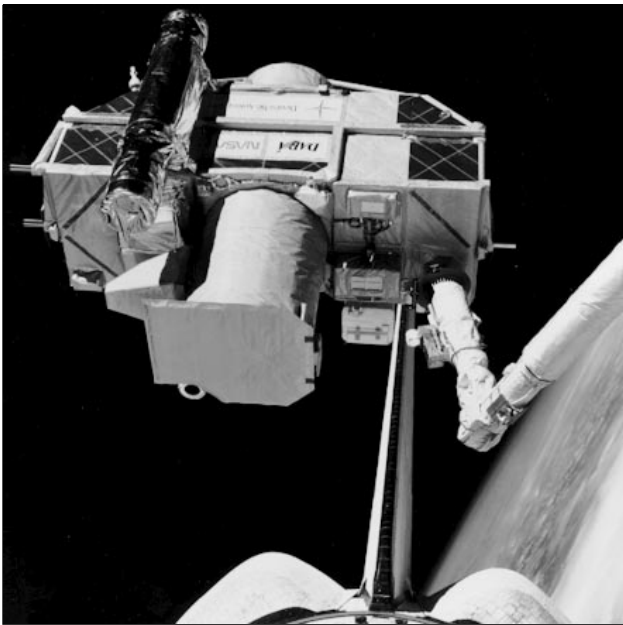
STS-51 crewmembers: (L to R), William F. Readdy, Daniel W. Bursch, Frank L. Culbertson, Jr., Carl E. Walz, and James H. Newman.

ACTS is testing a new technology that compensates for this effect. This will potentially open up Ka-band for wider use in space communications. The ACTS deployment was successfully completed 9.5 hours into the first day of the mission.

ORFEUS-SPAS

The deployment of ACTS-TOS on flight day one allowed the crew to turn their attention to the deployment of ORFEUS-SPAS. ORFEUS-SPAS represented the first in a planned series of four scientific missions cosponsored by NASA and the German Space Agency (DARA). ORFEUS uses the ASTRO-SPAS carrier, a free-flying platform that is a direct successor to the SPAS-1 system which flew on Shuttle missions STS-7 and 41-B. For this first flight, ASTRO-SPAS carried two primary instruments, the ORFEUS telescope and the Interstellar Medium Absorption Profile Spectrograph (IMAPS). Also flown were the Surface Effects Sample Monitor (SESAM), a materials science experiment aimed at measuring degradation of surfaces exposed to the near Earth space environment, and a Remote IMAX Camera System (RICS) to film the Orbiter during ORFEUS-SPAS deployment and retrieval sequences.

ORFEUS and IMAPS were designed to measure ultraviolet radiation, emitted by celestial objects that are extremely hot. For example, white dwarfs, the final remnant of low-mass stars such as our Sun, emit most of their dwindling energy reserves at far ultraviolet wavelengths. The far ultraviolet spectrograph covers spectra in the wavelength range of 90-125 nanometer range (a nanometer is one billionth of a meter). The extreme ultraviolet spectrograph covered wavelengths in the 40-120 nm range. By studying ultraviolet spectral lines, scientists can determine the chemical makeup, temperature, structure and motion of various celestial objects,



The ORFEUS with its SPAS carrier is held on the end of the RMS arm prior to final berthing for the voyage back to Earth.

information that cannot be gleaned from photographs. ORFEUS data could lead to a better understanding of how stars are born, how they evolve and die, and how they interact with the gas that fills the immense spaces between them. The IMAPS, which concentrated on observations of interstellar gas along the line-of-sight to bright, nearby stars, had the highest spectral resolution of any instrument ever flown in space.

ORFEUS-SPAS was deployed by the crew using the Orbiter's remote manipulator arm early into the second day of the mission and retrieved on the eighth day. Control of the payload was via the SPAS Payload Operations Center (SPOC) at Kennedy Space Center, with *Discovery*--64 km from ORFEUS-SPAS--serving as a relay station for command and telemetry. The Extended Range Payload Communications Link (ERPCL) was successfully used for the first time to increase the range of the Orbiter's relay function. Astronomers said the ORFEUS instruments performed beyond their expectations, collecting spectrographs of unparalleled resolution. A second flight of ORFEUS-SPAS is planned in about two years.

Extravehicular Activity (EVA)

On the fifth day of the flight, mission specialists Carl Walz and James Newman conducted an EVA, or spacewalk, to test tools, tethers, platforms, and methods to be used by EVA crewmembers on the Hubble Space Telescope servicing mission scheduled for later this year. The two were able to reassure the designers and planners of the Hubble mission that their preparations were sound.

Secondary Payloads and Medical Experiments

One other experiment was flying in the cargo bay, the Limited Duration Space Environment Candidate Material Exposure (LDCE), contained in two Get-Away Special canisters attached to the cargo bay wall. Its purpose was to expose developmental composite materials to the eroding effect of atomic oxygen in low Earth orbit. These materials are being examined for possible use in the construction of future spacecraft. Between deploying and retrieving satellites and conducting spacewalks, the crew was also busy working with eight experiments inside the Orbiter's crew compartment. The Commercial Protein Crystal Growth (CPCG) Block II is an ongoing effort to grow large, high-quality protein crystals in microgravity. The Chromosome and Plant Cell Division in Space (CHROMEX-04) studied plant growth in microgravity. The High-Resolution Shuttle Glow Spectroscopy (HRSGS-A) featured a spectrograph to study Orbiter surface glow. The Aurora Photography Experiment (APE-B) was also a Shuttle glow experiment. The Investigation into Polymer Membranes Processing (IPMP) was an experiment aimed at controlling porosity of a polymer membrane used by industry for molecular separation. The Radiation Monitoring Equipment (RME) III measured ionizing radiation exposure in the Orbiter crew compartment. The IMAX 70mm camera filmed general interior activities.

The crew continued research into microgravity's effect on the human body. Crewmembers participated in the evaluation of how their vision compensates for their inner ear's lack of balance in space. The crew also exercised on a stationary bike to counteract the effects of microgravity on the body.



Astronauts James Newman (in bay) and Carl Walz conduct a spacewalk to practice techniques and evaluate tools for the Hubble Space Telescope servicing mission scheduled later this year.

Mission Facts

Orbiter: *Discovery*

Mission Dates: September 12-22, 1993

Commander: Frank L. Culbertson (CAPT, USN)

Pilot: William F. Readdy (CDR, USNR)

Mission Specialist: Daniel W. Bursch (CDR, USN)

Mission Specialist: James H. Newman (Ph.D.)

Mission Specialist: Carl E. Walz (LTCOL, USAF)

Mission Duration: 9 days, 20 hours, 11 minutes

Kilometers Traveled: 6,507,936

Orbit Inclination: 28.5 degrees

Orbits of Earth: 158

Orbital Altitude: 296 km

Payload Weight Up: 12,197 kg

Orbiter Landing Weight: 93,545 kg

Landed: Kennedy Space Center Runway 15

Payloads and Experiments:

ACTS/TOS - Advanced Communications
Technology Satellite/Transfer Orbit Stage
ORFEUS/SPAS - Orbiting Retrievable Far and
Extreme Ultraviolet Spectrometer/Shuttle
Pallet Satellite

CPCG - Commercial Protein Crystal Growth Block II
CHROMEX - Chromosome and Plant Cell Division
in Space

HRSGS-A - High Resolution Shuttle Glow
Spectroscopy

IMAX - Image Maximum Camera

APE-B - Aurora Photography Experiment

IPMP - Investigation into Polymer Membrane
Processing

RME-III - Radiation Monitoring Equipment

LDCE - Limited Duration Space Environment
Candidate Materials Exposure

AMOS - Air Force Maui Optical Site calibration



STS-51 Crew Patch

Crew Biographies

Commander: Frank L. Culbertson, Jr. (CAPT, USN)

Frank Culbertson was born in Charleston, South Carolina, but considers Holly Hill, South Carolina, to be his hometown. He earned a bachelor of science degree in aerospace engineering from the U.S. Naval Academy. Culbertson served in the Gulf of Tonkin aboard the USS *Fox* during the Vietnam War before being designated a naval aviator. He trained as an F-4 Phantom pilot, and served aboard the USS *Midway* out of Yokosuka, Japan. After assignments with the USAF and aboard the USS *John F. Kennedy*, he graduated with distinction from the U.S. Naval Test Pilot School. He was program manager for all F-4 testing and a test pilot for automatic carrier landing systems in the Carrier Systems Branch at the Naval Air Test Center. He was training in the F-14A Tomcat until his selection as an astronaut candidate in 1984. He has logged over 4,400 flying hours in over 40 different types of aircraft and made over 450 carrier landings. Culbertson served as pilot on STS-38 and was most recently Deputy Chief of the FCOD Station-Exploration Support Office.

Pilot: William F. Readdy (CDR, USNR)

William Readdy was born in Quonset Point, Rhode Island. He earned a bachelor of science degree in aeronautical engineering in 1974 from the U.S. Naval Academy. Following designation as a naval aviator and training in the A-6 Intruder, he served aboard the USS *Forrestal* in the North Atlantic and Mediterranean. After working as a test pilot at Patuxent River, Maryland, he served as a strike operations officer on the USS *Coral Sea*, flying A-6 and F/A-18 Hornet aircraft. He has logged over 5,500 hours of flying time in more than 60 types of fixed wing aircraft and helicopters, and made over 550 carrier landings. Selected as an astronaut candidate in 1987, Readdy flew on STS-42 aboard *Discovery*, logging 193 hours in space.

Mission Specialist: Daniel W. Bursch (CDR, USN)

Daniel Bursch was born in Bristol, Pennsylvania, but considers Vestal, New York, his hometown. He earned a bachelor of science degree in physics from the U.S. Naval Academy, and a master of science degree in engineering science from the Naval Postgraduate School. After training as an A-6E Intruder bombardier/navigator, he served aboard the USS *John F. Kennedy* and USS *America*. After working as a project test flight officer for the A-6 Intruder, he served as a flight instructor at the U.S. Naval Test Pilot School. Bursch worked as Strike Operations Officer for Commander, Cruise-Destroyer Group 1, making deployments to the Indian Ocean aboard the USS *Long Beach* and USS *Midway*. He has over 1,800 flight hours in more than 35 different aircraft. Bursch became an astronaut in 1991. This was his first space flight.

Mission Specialist: James H. Newman (Ph.D.)

James Newman was born in the Trust Territory of the Pacific Islands, but calls San Diego, California, his home. He received a bachelor of arts degree in physics from Dartmouth College, and a master of arts degree and a doctoral degree in physics from Rice University. He was appointed an adjunct professor in the Department of Space Physics and Astronomy at Rice University, with research interests in atomic and molecular physics. While working at NASA Johnson Space Center, his responsibilities have included conducting flight crew and flight control team training for all Shuttle mission phases in the areas of orbital propulsion, guidance and control. Selected as an astronaut candidate in 1990, this was his first space flight.

Mission Specialist: Carl E. Walz (LTCOL, USAF)

Carl Walz was born in Cleveland, Ohio. He received a bachelor of science degree in physics from Kent State University, and a master of science degree in solid state physics from John Carroll University. While stationed at McClellan Air Force Base in California, he worked as a radiochemical project officer, responsible for analysis of radioactive samples from the Atomic Energy Detection System. As a flight test engineer at the F-16 Combined Test Force, Edwards Air Force Base, he worked on F-16C avionics and armament development programs, flying F-4 and F-16 aircraft. He also served as a flight test program manager at Detachment 3, Air Force Flight Test Center. Walz became an astronaut in 1991. This was his first space flight.